

COMBINING ABILITY ANALYSIS IN RABI SORGHUM (SORGHUM BICOLOR L. MOENCH)

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Abstract: The eighteen parents were crossed in Line X Tester mating design involving three cytoplasmic genetic male sterile lines and fifteen testers at Sorghum Improvement Project, M.P.K.V., Rahuri during rabi 2013-2014. The observations were recorded on twelve characters viz., days to 50% flowering, plant height, number of internodes, panicle length, panicle girth, panicle weight, 1000-seed weight, days to maturity, fodder yield per plant, grain yield per plant, harvest index and dead heart (%). Based on results obtained on per se performance, general and specific combining ability, the hybrid 185 A x RSV 1093, 185 A x RSV 458, RMS 2010-10A x RSLG 2291, RMS 2010-24A x CSV 216, 185A x RSV 1145 were observed most promising and could be exploited for further hybrid development. While, the parents 185A, RMS 2010-10B, RSV 1093, RSV 458, RSLG 1145 and CSV 216 should be used in future hybridization programme.

Keywords: Combining ability, GCA, SCA and sorghum.

Introduction: Sorghum [*Sorghum bicolor* (L.) Moench] is the fifth important cereal of the world after wheat, maize, rice and barley. Sorghum is believed to be originated in Africa and spread all over the world. The large hecta rage of sorghum occurs in the arid and semi-arid areas of India and Africa. In India, 75% of sorghum area and 85% of production is concentrated in the three states viz., Maharashtra, Karnataka, and Andhra Pradesh. Only about 8% of area is under irrigated.

Line x tester analysis for combining ability (10,1) is one of the powerful tools for identification of the best combining parents which may be hybridized to exploit heterosis or to accumulate desirable alleles. It is also helpful for assessing the nature and magnitude of gene action controlling the inheritance of quantitative traits.

The concept of combining ability plays an important role in identification of superior parents and hybrids. Allard pointed out that the common approach of selecting the parents on the basis of per se performance is not a good indication of their superior combining ability. The choice of parents in any breeding programme has to be based on complete genetic information and knowledge of combing ability of parents and not merely on field performance of different genotype.

In the present investigation on, "Combining ability analysis in rabi sorghum (*Sorghum bicolor* L. Moench)" by line x tester analysis, performance of 45 Fi's as compared to three male sterile lines (females), fifteen testers (males) and one standard check has been studied to estimate the general combining ability effects and specific combining ability effects of parents and its crosses

Material and Methods: The experimental material for the present study comprised of three lines (females), fifteen testers (males), their resulting 45 hybrids and one hybrid check CSH-15R.

During rabi 2013-14, three male sterile lines and fifteen testers were sown at Sorghum Improvement Project, MPKV, Rahuri and these lines and testers were crossed in line x tester design to produce 45 possible hybrids. The experiment was conducted during rabi 2014-15 by using eighteen parents, their 45 possible hybrids along with one standard check CSH-15R at Sorghum Improvement Project, MPKV, Rahuri. The observations were recorded on twelve characters viz., days to 50% flowering, plant height, number of internodes, panicle length, panicle girth, panicle weight, 1000-seed weight, days to maturity, fodder yield per plant, grain yield per plant, harvest index and dead heart (%).

The combining ability analysis for 45 hybrids was carried out as per the procedure developed by Kempthorne (1957) and modified by Arunachalam (1974).

Result and Discussion: From the analysis of variance for combining ability (Table 1), it is observed that the mean sum of squares due to treatments were highly significant, which indicates presence of substantial variability.

General combining ability: The estimates of gca effects of lines & testers are presented in table 2. The line 185 A was the best general combiner for eight characters i.e. grain yield per plant, days to 50 % flowering, panicle length, panicle girth, panicle weight, days to maturity, thousand seed weight and harvest index. The second preference given to line RMS 2010-10A which had given highly significant positive gca effects for plant height, fodder yield per plant and thousand seed weigh. For characters like days to 50% flowering and days to maturity negative gca values are desirable. The line 185 A was found to be suitable for developing high yielding and early maturing hybrids in rabi sorghum (15,16). Among tester RSV 458 exhibited significant negative gca effects for two characters like days to 50% flowering

and days to maturity. The tester RSLG 2291 showed significant desirable gca effects for two characters viz., panicle girth and panicle weight. The tester RSV 1145 showed significant positive gca effects for grain yield per plant and panicle weight, while tester RSV 1009 best general combiner for panicle weight and fodder yield per plant. Thus these four testers can be used in new hybrid development programme (16).

In general good combiners for grain yield also had good or average combiners for one or more yield components. In most of the parents high GCA effects were associated with high per se mean for yield and yield components (2, 3, 11, 13, 14, 15, 18).

Specific combining ability: The estimate of promising are presented in table 3.

Days to 50% flowering:The hybrid RMS 2010-10A x RSV 458 (average x high) observed best specific combiner for days to 50 % flowering. The data revealed that the hybrid showing significantly high SCA effects having average x high GCA effects of parents(5).

Panicle length (cm): For character panicle length the hybrid RMS 2010-10A x RSV 912 (low x average) showed the higher magnitude of positive specific combining ability effects. This hybrid showed significantly high SCA effects involves low x average GCA effects of parents.

Panicle girth (cm): Among the hybrids, two hybrids showed significant positive specific combining ability effects. The hybrid combinations RMS 2010-10A x RSV 1098 (low x average) and 185 A x RSV 1200 (high x average) exhibited the higher magnitude of positive specific combining ability effects. From the data it was observed that hybrids with positive significant SCA involved low x average, high average GCA effects of parents (8, 9).

Panicle weight (g): Two crosses viz., RMS 2010-10A x RSV 912 and RMS 2010-10A x RSV 458 were observed best specific combiners which involved low x low GCA effects of parents (7).

1000 seed weight (g):The hybrid combinations viz., 185 A x RSV 1145 (high x average), 185 A x RSV 1093 (high x average) and RMS 2010-24A x RSR 2231 (low x average) observed best specific combiners for 1000 seed weight involved high x average and low x average GCA effects of parents (8, 9, 11).

Days to maturity: Six hybrids showed highly significant negative SCA effects for days to maturity. The hybrid combinations RMS 2010-10A x RSV 1093 exhibited highly significant negative SCA effects followed by RMS 2010-24A x RSV 1145, RMS 2010-24A x RSV 912, RMS 2010-24A x RSV 1151, RMS 2010-10A x CSV 216 and RMS 2010-24A x RSV 1009 for days to

maturity. These hybrids showed highly significant SCA effects involving low x average, low x low GCA effects of parents (11, 13).

Fodder yield per plant (g): The hybrid 185 A x RSR 2231 (average x average) recorded positively significant SCA effects for fodder yield per plant. The data revealed that the hybrid showed significantly SCA effects having average x average GCA effects of parents(18, 19).

Grain yield per plant (g): Two hybrids showed positively significant SCA effects for grain yield per plant. The hybrid combinations viz., 185 A x RSV 1093 (high x average), RMS 2010-24A x CSV 216 (low x average) were best specific combiners. The data revealed that the hybrids showing high magnitude of specific combining ability effects having high x average and low x average GCA effects indicated the presence of non additive gene action (5, 6, 8, 9, 11, 13, 18, 19).

Harvest index (%): The hybrid 185 A x RSV 1093 (high x average) showed positively significant SCA effects. The data revealed that hybrid showing high magnitude of positive SCA effects involved high x average GCA effects of parents(19).

The ratio of GCA variance to SCA variance less than unity for grain yield per plant, days to maturity, panicle girth, panicle weight and number of internodes indicating presence of non additive gene action, whereas more than unity for days to 50% flowering, plant height, panicle length, 1000 seed weight, fodder yield per plant and harvest index indicating presence of additive type of gene action (6, 8, 11 19).

Conclusions: The female parent 185 A observed as a good general combiners for grain yield per plant, days to 50% flowering, days to maturity, panicle length, panicle girth, panicle weight, 1000 seed weight and harvest index. Among the testers, tester RSV 1145 recorded positively significant superior gca for grain yield and panicle weight, while tester RSV 458 took minimum days to 50% flowering and days to maturity.

The hybrids which exhibited higher SCA for grain yield having average or good general combiner for other traits. From the studies it was observed that the hybrids 185A x RSV 1093, RMS 2010-24A x CSV 216 were observed best specific combiners for grain yield per plant.

The higher magnitude of SCA variance over GCA variance was observed in grain yield per plant, days to maturity, panicle weight and panicle girth which indicate the importance of non additive gene action for these characters.

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Table 1. ANOVA for combining ability for eleven characters in *rabi* Sorghum (L x T design).

Sources of variation	D.F	Days to 50% flowering	Plant height (cm)	No. of internodes	Panicle length (cm)	Panicle girth (cm)	Panicle weight (g)	1000 Seed weight (g)	Days to maturity	Fodder yield per plant (g)	Grain yield/Plant (g)	Harvest index (%)
Repl ^{ns}	1	10.86	152.08	0.50	2.89	0.0004	338.33	175.91	11.46	5293.64	1.14	59.87
Treat.	62	20.73**	1187.57**	1.084*	11.82**	5.28**	533.07**	29.44**	8.29**	5190**	218.29**	53.24*
Parents	17	26.73**	2680.11**	1.89**	7.67**	5.61**	468.94**	28.76**	9.70**	8290.89**	263.80**	70.34**
Females	2	28.16**	344.487	0.32	4.00	1.01	13.54	20.15	37.50**	464.68	24.42	114.61*
Males	14	23.37**	393.46	0.44	6.45**	6.17**	484.59**	20.10**	4.70**	2822.33	209.37*	36.95
Female vs Male	1	70.93**	39364.47**	25.38**	32.00**	6.89*	1160.63**	167.31**	24.20**	100503.11**	1504.53**	449.35**
Parents vs Crosses	1	51.60**	446.73	0.14	421.84**	65.27**	3815.65**	105.80**	26.86**	25348.77*	165.17	62.54
Crosses	44	17.70**	627.75**	0.79	4.10*	3.79**	483.24**	27.97**	7.32**	3533.78**	201.91**	46.43
Error	62	1.97	260.60	0.70	2.33	1.48	159.94	7.47	0.78	1779.59	105.01	30.47
σ^2 gca		3.65	155.07	0.08	0.66	0.35	31.32	8.65	0.77	791.68	17.91	8.34
σ^2 sca		1.63	-2.59	-0.14	0.26	1.13	140.44	4.75	2.43	160.74	34.97	3.87
σ^2 gca/ σ^2 sca		2.23	-59.87	-0.57	2.53	0.31	0.22	1.82	0.31	4.92	0.51	2.15
σ^2 A		7.30	310.14	0.16	1.31	0.69	62.64	17.29	1.54	1583.37	35.83	16.68
σ^2 D		1.63	-2.59	-0.14	0.26	1.13	140.44	4.75	2.43	160.74	34.97	3.87
σ^2 A/ σ^2 D		4.48	-119.74	-1.14	5.03	0.61	0.45	3.65	0.63	9.85	1.02	4.31

Note: *, ** = Significant at 5% and 1% level of significance respectively.

Table 2. Estimates of GCA effects of parents for eleven characters in *rabi sorghum*.

Sr. No.	Parents	Days to 50% flowering	Plant height (cm)	No. of internodes	Panicle length (cm)	Panicle girth (cm)	Panicle weight (g)	1000 seed weight (g)	Days to maturity	Fodder yield per plant (g)	Grain yield/Plant (g)	Harvest index (%)
Females												
1	185 A	-2.05**	-0.98	0.08	0.77*	0.74*	6.14*	1.46*	-0.94**	-7.94	5.25**	2.89**
2	RMS20 10-10A	0.44	13.90**	0.28	0.99*	-0.47*	-4.86*	2.26*	0.35*	34.48**	-1.39	-3.69**
3	RMS20 10-24A	1.61**	12.91**	-0.36*	0.21	-0.27	-1.27	3.72*	0.58**	26.54**	3.85*	0.8
	SE (m) ₊	0.25	2.94	0.15	0.27	0.22	2.30	0.49	0.16	7.70	1.87	1.00
	CD at 5%	0.51	5.94	0.30	0.56	0.44	4.65	1.00	0.32	15.52	3.77	2.03
	CD at 1%	0.69	7.93	0.41	0.75	0.59	6.21	1.34	0.43	20.73	5.03	2.71
Males												
4	RSR-2231	-1.22*	-6.58	-0.75*	0.07	-1.01*	-8.67	1.14	-0.31	19.36	-4.00	-2.90
5	RR-2145	2.11**	5.41	-0.08	0.15	-0.65	-0.47	-0.52	2.35**	-3.36	-0.87	0.66
6	RSV-1059	0.27	-4.12	0.44	-0.99	-0.46	-6.47	0.80	0.68	19.10	5.99	-0.72
7	RSV-799	-1.05	4.40	0.18	-0.13	-0.57	-7.61	-1.32	-0.81*	21.46	8.47*	-1.86
8	CSV-216	1.11	-7.32	-0.15	-0.03	0.16	0.85	2.25*	0.52	-0.58	1.17	0.02
9	RSV-1093	0.44	13.05	0.48	1.23	-0.29	-6.87	-0.77	0.18	-0.36	6.24	3.76

Table 2.Contd.....

Sr. No.	Parents	Days to 50% flowering	Plant height (cm)	No. of internodes	Panic le length (cm)	Panic le girth (cm)	Panic le weight (g)	1000 seed weight (g)	Days to maturity	Fodder yield per plant (g)	Grain yield / Plant (g)	Harvest index (%)
10	RSV-1200	0.44	1.55	0.38	-0.09	-0.38	-2.67	-1.35	-0.47	-22.01	-4.32	0.14
11	RSV-912	1.94**	17.78**	-0.92**	0.51	-0.10	-9.34	0.17	1.35**	-33.46	-5.47	2.32
12	RSV-458	-7.38**	21.96**	-0.62	-0.49	0.16	-1.67	-1.24	-3.31**	-13.66	1.12	1.80
13	RSV-1098	0.94	18.88**	0.41	-1.39*	0.18	-3.14	0.44	0.02	3.25	1.11	0.46
14	RSV-1130	1.27*	7.37	0.31	-0.42	0.37	2.15	1.76	0.52	2.43	-0.39	-1.20
15	RSV-1151	0.27	-1.72	-0.05	-0.97	-0.41	-4.54	0.61	-0.14	-7.58	-2.32	0.78
16	RSV-1145	0.61	6.58	0.31	0.95	0.62	11.92*	0.53	-0.31	25.63	11.34**	1.07
17	RSLG-2291	-0.22	-1.34	-0.02	1.07	1.50*	16.78**	1.69	-0.31	29.31	5.01	-2.25
18	RSV-1009	0.44	3.57	0.08	0.54	0.88	19.78**	0.28	0.02	41.61*	8.19	-2.10
	SE (m) +	0.57	6.59	0.34	0.62	0.49	5.16	1.11	0.36	17.22	4.18	2.25
	CD at 5 %	1.15	13.28	0.68	1.25	1.00	10.40	2.24	0.72	34.70	8.43	4.54
	CD at 1 %	1.54	17.74	0.92	1.68	1.33	13.9	3.00	0.97	46.36	11.26	6.06

Note: *, ** = Significant at 5% and 1% level of significance respectively.

Table 3. Estimates of SCA effects of promising hybrids for eleven characters in *rabi sorghum*.

Sr. No.	Hybrids	Days to 50% flowering	Plant height (cm)	No. of internodes	Panicle length (cm)	Panicle girth (cm)	Panicle weight (g)	1000 Seed weight (g)	Days to maturity	Fodder yield per plant (g)	Grain yield/Plant (g)	Harvest index (%)
1	185 A x RSR-2231	-1.778	-0.158	0.453	0.029	-0.465	-0.676	-0.18	-1.556*	63.543*	1.783	-3.503
2	185 A x RSV-1093	0.056	-2.218	0.02	1.059	0.709	14.124	4.059*	0.944	-5.523	20.133**	8.052*
3	185 A x RSV-1200	-1.944	-14.062	0.12	-0.019	2.000*	16.124	-1.166	-0.389	-34.323	5.75	5.346
4	185 A x RSV-912	0.056	9.063	0.02	-1.456	-1.781*	-	1.82	0.278	3.227	-2.95	0.826
5	185 A x RSV-1098	0.056	1.665	0.287	0.291	-0.493	8.191	-1.368	-0.389	9.01	-0.333	-2.604
6	RMS 2010-10A x RSR-2231	2.722**	-9.821	0.253	0.272	0.137	13.931	-3.723	2.144**	-26.933	7.38	4.59
7	RMS 2010-10A x RSV-1098	0.056	-0.868	-0.213	-1.242	2.539**	-2.002	1.414	0.311	6.083	-0.437	-0.472
8	RMS 2010-10A x RSV-1145	-1.611	-14.646	0.187	-1.123	-0.708	-16.269	-5.129*	0.144	-35.45	-12.07	-0.312
9	RMS 2010-24A x RSR-2231	-0.944	9.98	-0.707	-0.301	0.328	-13.256	3.902*	-0.589	-36.61	-9.163	-1.087
10	RMS 2010-24A x RR-2145	-0.278	-1.862	0.427	-0.841	0.071	0.944	-1.243	0.744	3.323	-5.547	-4.953
11	RMS 2010-24A x CSV-216	-0.278	-16.435	0.093	1.146	0.266	12.811	1.299	1.078	-19.21	14.653*	7.662
12	RMS 2010-24A x RSV-1093	1.389	6.375	0.26	-0.256	0.551	1.944	-2.229	2.411**	-15.477	-7.063	-2.107
13	RMS 2010-24A x RSV-1098	-0.111	-0.797	-0.073	0.951	-2.045*	-6.189	-0.046	0.078	-15.093	0.770	3.077
14	RMS 2010-24A x RSV-1145	-0.278	9.710	0.527	0.824	0.358	7.144	-1.614	-2.089**	-17.677	2.337	2.892
15	RMS 2010-24A x RSV-1009	-0.611	4.278	0.06	0.264	-0.332	5.878	-0.936	-1.422**	55.44	4.537	-3.048
	SE (m) +	0.99	11.41	0.59	1.08	0.86	8.94	1.93	0.62	29.82	7.24	3.90
	CD at 5 %	2.00	23.00	1.19	2.17	1.73	18.02	3.89	1.26	60.11	14.60	7.86
	CD at 1 %	2.67	30.73	1.59	2.90	2.31	24.07	5.20	1.68	80.30	19.50	10.50

Note: *, ** = Significant at 5% and 1% level of significance respectively.

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